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How Accurate Are UK's Nitrogen Recommendations for Corn?

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How Accurate Are UK's Nitrogen Recommendations For Corn?

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Average corn yields produced on soils with high yield potential have steadily been increasing in Kentucky during the past several years. Yields from such soils in years with adequate amounts of rainfall well distributed over the growing season (May-September) may average 180 to 200 bushels per acre. A bushel of corn with crude protein content of 8 to 9% contains about 1.3 to 1.4% total nitrogen (N) on a dry matter basis. This is about 0.6 to 0.7 lbs total N per bushel of corn (at 15.5% moisture), or 108 to 126 lbs N per acre for a 180 bu/A crop. Some growers question that UK's fertilizer N recommendations will support such yield production.

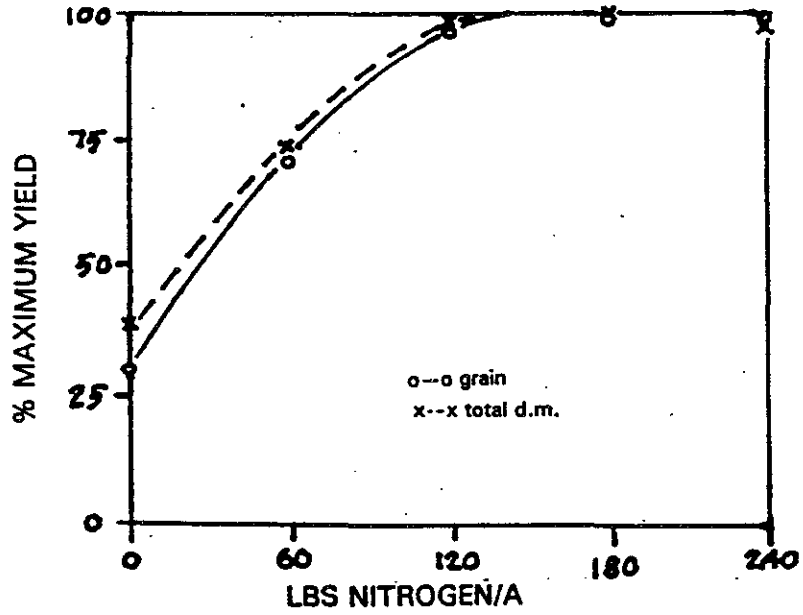
We have conducted a long-term study of no-till corn production since 1981 at UK's Robinson Experiment Station at Quicksand, KY, in which we have tested N rates, N sources, and time of N application in various studies on a Pope silt loam soil. Average yield for the past 16 years of continuous no-till corn with 160 lbs of fertilizer N/A in this study was 169 bu/A. Yields ranged from 134 to 218 bu/A, with the 218 bu/A yield occurring in 1996. During this 16 year period, yields have exceeded 180 bu/A in 6 years, and have exceeded 150 bu/A in 12 of the 16 years. Average yields below 150 bu/A have always been associated with lower than normal amounts and poorly distributed rainfall. UK's published recommendation for continuous no-till corn grown on well-drained soils is 125 to 150 lbs N/A. During 1994-1995, we tested rates of N up to 240 lbs/A at this site. Details and results from this study are explained below.

Description of Study

Pope soils developed in medium-textured alluvial deposits along major streams in eastern Kentucky. These soils are deep, well-drained, and have a high

potential for corn production where growing season flooding is not a problem. On this study site during 1994 and 1995, pH of the top 3 inches of soil averaged 6.4, organic matter content of about 3.0%, soil test level (lbs/A) of P was 88, K was 224, Mg was 204, and Zn was 4 as measured by the UK Soil Testing Laboratory. Soil test levels were much lower in the 3- to 6-inch soil depth, with averages being P 21, K 138, Mg 137, and Zn 2.5. No P_2O_5 was applied, while 68 lbs/A of K_2O was topdressed at planting each year. The corn variety used was Pioneer 3140, no-till planted in mid-May in 36 inch rows into old corn stubble and weeds at 24,000 seeds/A. Harvested population was about 22,000 stalks/A. Although this variety has some tolerance, gray leaf spot disease may have lowered yields somewhat. The occurrence of gray leaf spot disease is common at this site and probably lowers yields during years when it is severe before corn is mature. Rates of N tested were 0, 60, 120, 180, and 240 lbs/A, applied when corn was 12 inches tall as ammonium nitrate. Treatments were randomized in blocks, with four replications. Plot size was 40 ft long x 12 ft (4 rows) wide. Ear-leaf samples were taken at silking and tasseling for measuring N content. Total above ground dry matter production (grain + stover) was estimated from harvesting 10 whole stalks from the center two rows of each plot. After weighing, drying, and grinding, total N content was measured. Grain yields were estimated by hand harvesting 25 ft from each of the two inside rows of each plot in mid-October, and were adjusted to 15.5% moisture.

FIGURE 1. Response of No-Till Corn to Nitrogen Application on a Well-Drained Soil AV. 1994-1995



How Much Fertilizer N Was Required For Top Yields?

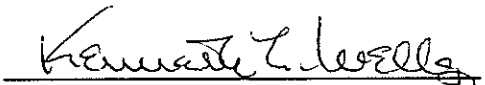
Figure 1 illustrates the grain and dry matter yield response to fertilizer N reported in tables 1 & 2. Based solely on absolute numerical values, 97% of maximum grain and 99% of maximum dry matter yields were obtained with 120 lbs of fertilizer N/A. As is shown by the statistical data in the tables, there was no significant difference in rates of N above 120 lbs/A on either grain or total dry matter yields. These results agree with UK's recommendations for continuous no-till corn production on a well-drained soil.

How Much Total N Was Required For Top Yields?

As shown in Table 1, this soil is capable of providing enough plant available N for about 50 bu/A of grain production without applying any fertilizer N. Assuming the N content of grain to be 1.3% (8.1% crude protein) on a dry matter basis, this means that the soil provided about 30 lbs N/A for the grain. Another 10 lbs N/A was provided by the soil from the recycled stover, which means that the soil provided about 40 lbs N for total dry matter production (stover + grain) even after 15 consecutive years without the use of fertilizer N. For maximum production during 1994-1995 (164 bu grain or 22 tons silage per acre), total plant N uptake was 142 lbs/A. This means that it took 0.86 lbs of fertilizer plus soil N/ac to produce the stover and grain for 1 bu of corn, including N provided by the soil. Analysis of the data from Tables 1-4 shows further, that an estimated 70% of all the N in the whole plant was in the grain, with the remaining 30% in the stover. We estimated the amount of fertilizer N contained in the whole plant by subtracting the 40 lbs of N which the soil provided (total N uptake in control plots) from the 142 lbs taken up by the crop at maximum yield (164 bu grain or 22 T silage). This indicates that 102 lbs of the N taken up by the crop came from the 120 lbs/A of fertilizer N applied (85% recovery of fertilizer N). On this basis, 28% of the N (40/142) came from the soil and 72% (102/142) came from the fertilizer. So, for the 0.86 lbs total N (stover + grain) required to produce a bushel of corn, 0.24 lb (0.86 x 0.28) came from the soil and 0.62 lb (0.86 x 0.72) came from the fertilizer. This is about half of the 1 to 1.5 lbs of fertilizer N often quoted as being needed per bushel of corn production for high yields.

Summary

High levels of corn production (an average of 169 bu/A during 16 years of continuous no-till corn production at this site) have been obtained from this deep, well- drained,
bottomland soil with use of 160 lbs fertilizer N/A. Detailed analysis of an N rate study conducted during 1994 and 1995 shows that 120 lbs fertilizer N/A plus 40 lbs of soil N was sufficient to produce maximum corn yields at this site. This optimum N rate compares well with the 125 to 150 lbs fertilizer N/A recommended by UK for continuous no-till corn production on well-drained soils.



Extension Soils Specialist

Table 1. Effect of N Rates on Grain Yield

Corn Grain Yields (bu/A @ 15.5% moisture)				% Max. Yield
lbs N/A	1994	1995	2-Yr Av	2-Yr Av
0	59d	43d	51	30
60	126b	114b	120	71
120	185a	142a	164	97
180	193a	141ab	167	99
240	186a	151a	168	100
L.S.D. (.05)	18.8	28		
% c.v.	9.1	17.0		

Table 2. Effect of N Rates on Total Dry Matter

Total Above-Ground Dry Matter (Grain + Stover), T/A				% Max. Yield
lbs N/A	1994	1995	2-Yr Av	2-Yr Av
0	3.40d	3.10d	3.25	38
60	7.20c	5.31c	6.25	74
120	9.11a	7.66a	8.38	99
180	9.44a	7.47a	8.45	100
240	9.02a	7.71a	8.36	99
L.S.D. (.05)	1.43	1.12		
% c.v.	14	13.5		

Table 3. Effect of N Rates on Ear-Leaf N

Ear-Leaf N Content (%)			
lbs N/A	1994	1995	2-Yr Av
0	2.05d	1.70c	1.87
60	2.51c	2.42b	2.46
120	3.18b	2.80a	2.99
180	3.31ab	2.81a	3.06
240	3.36ab	2.83a	3.09
L.S.D. (.05)	0.23	0.26	
% c.v.	5.6	7.3	

Table 4. Effect of N Rates on Whole Plant N

Whole Plant N Content (%)			
lbs N/A	1994	1995	2-Yr Av
0	0.61c	0.66d	0.63
60	.55c	.69c	.62
120	.82b	.89ab	.85
180	.93a	.95a	.94
240	1.00a	.96a	.98
L.S.D. (.05)	0.8	.09	
% c.v.	7.7	8.0	

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